DOCUMENT RESUME

ED 048 463 VT 012 452

AUTHOR	McCall, John J.
TITLE	Racial Discrimination in the Job Market: The Role of Information and Search.
INSTITUTION	Rand Corp., Santa Monica, Calif.
SPONS AGENCY	Office of Economic Opportunity, Washington, D.C. Office of Planning, Research, and Evaluation.
REPORT NO	RM-6162-OEO
PUB DATE	Jan 70
NOTE	35p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$3.29
DESCRIPTORS	*Economic Factors, *Economic Research, Employee Attitudes, Employer Attitudes, Employment Practices, Equal Opportunities (Jobs), Information Needs, *Labor Market, Negro Employment, *Racial Discrimination, *Risk

ABSTRACT

The theory developed in this study assumes that the value of discrimination is positive, and its magnitude is a function of the business cycle. A changing economic environment induces employers to engage in experiments, such as hiring nonwhites in periods of tight labor markets. When these experiments alter emplcyer attitudes, reduced discrimination can result. Similarly, employee experimentaticn in a tight labor market can change their beliefs regarding the intensity of discrimination. Using a Bayesian model to analyze uncertainty, the theory provides an economic explanation for discriminaticn and its cure. (BH)

EDO 48463

0 - 1 (1)
1

MEMORANDUM
RM-6162-OEO
JANUARY 1970

RACIAL DISCRIMINATION IN THE JOB MARKET: THE ROLE OF INFORMATION AND SEARCH

John J. McCall

PREPARED FOR:
OFFICE OF ECONOMIC OPPORTUNITY

VT0124452

The RAND Corporation
SANTA MONICA • CALIFORNIA

ED 048463

MEMORANDUM
RM-6162-OEO
JANUARY 1970

RACIAL DISCRIMINATION IN THE JOB MARKET: THE ROLE OF INFORMATION AND SEARCH

John J. McCall

The Research reported herein was performed under contract with the Office of Economic Opportunity, Executive Office of the President, Washington, D.C., 20506. The opinions expressed herein are those of the author and should not be construed as representing the opinions or policy of any agency of the United States Government.

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY

The RAND Corporation
1700 MAIN ST. • SANTA MONICA • CALIFORNIA • 90406

This study is presented as a competent treatment of the subject, worthy of publication. The Rand Corporation vouches for the quality of the research, without necessarily endorsing the opinions and conclusions of the authors.

Published by The RAND Corporation

PREFACE

Under Contract B99-4944 with the Office of Economic Opportunity, a study group at The Rand Corporation is examining obstacles encountered by disadvantaged workers in securing and holding worthwhile jobs. The present Memorandum is an analysis of racial discrimination in job markets where the presence of uncertainty is explicitly considered. Employee as well as employer discrimination is addressed in the analysis.

The models presented here are preliminary and have not been empirically tested. Nevertheless, they do provide new insights into the discrimination phenomenon and suggest the kind of empirical research that should be undertaken. If the models are valid, the most important policy implication is that tight labor markets play an important role in the reduction of racial discrimination.

The Memorandum should be of interest to decisionmakers in the Office of Economic Opportunity; the Department of Health, Education and Welfare; the Department of Labor; and the Council of Economic Advisors.

SUMMARY

In the literature on job market discrimination a question that frequently arises is the economic value of discrimination accruing to the discriminator (in the case to be discussed here, the employer). Is it positive or negative? If positive would it pay the minority group to engage in retaliatory discrimination? The answers to such questions have usually been obtained by applying a static economic model. Different answers are given depending on which static model is used. The answer to this question is quite important from a policy perspective. If discrimination does not pay economically, then one can estimate the cost of indulging this taste. Employers may then decide that the cost is too high and reduce discrimination without altering their attitudes toward non-whites. If discrimination does pay economically, then different and perhaps more complex policies may be required to reduce it. It will be argued here that in the presence of uncertainty, discrimination may be economically justified for both the white employer and the non-white employee.

The employer discriminates on the basis of color if when presented with two individuals, one non-white and one white, who are otherwise equally qualified (on the basis of variables such as education, experience, age, sex, and so on) for a single job occupancy, he does not flip a fair coin and choose the non-white if a head appears and the white if tails (or vice versa). If the probability of a head is less than one half he discriminates against non-whites; if this probability exceeds one half he discriminates against whites. Employees discriminate if they do not search for employment with the same intensity in firms and industries that are similar with respect to such variables as distance from home, wage rates, and so on and only differ in the proportions of non-whites in their labor forces.

It pays employers to discriminate because information concerning the productivity of a potential employee is quite costly. He will, therefore, use color as a cheap screening device in the same way that he uses a high school diploma. He does this because he believes that

the probability that an employee will be productive given that he's non-white is less than the corresponding conditional probability for whites. In the same way, it pays non-whites to restrict their job searching activities to firms that have a relatively high proportion of non-white employees, the belief being that this proportion is a good measure of employer discrimination.

Nevertheless, although the value of discrimination is positive, the theory presented here assumes the value is a function of the business cycle. A changing economic environment is assumed to induce employers to engage in experiments, for example, hire non-whites in periods of tight labor markets. The outcomes of these experiments may alter his attitude toward non-whites, and in this way discrimination could decline in a very natural way. Similarly, with non-white employees, their beliefs regarding the intensity of discrimination in certain industries would never be altered unless they or someone in their information network were employed by these industries. Again in periods of tight labor markets, employees are also assumed to be experimenting with new industries and revising their beliefs concerning discrimination intensities. The main point in both of these illustrations is that discrimination by both employers and employees is explicable on purely economic grounds when uncertainty is explicitly considered and, furthermore, changes in the economic environment may cause both employers and employees to alter the beliefs that give rise to discriminatory practices.

ACKNOWLEDGMENTS

The author is indebted to Rand colleagues K. J. Arrow, A. J. Alexander, S. J. Carroll, J. Hirshleifer, A. Pascal, S. J. Press and A. Wohlstetter for their valuable comments and suggestions.

CONTENTS

PREFACE. iii

SUMMARY. v

ACKNOWLEDGMENTS. vii

Section

I. INTRODUCTION. 1

II. SOME EMPIRICAL RESULTS ON RACIAL DISCRIMINATION IN THE JOB MARKET 5

III. STATIC MODELS OF RACIAL DISCRIMINATION. 9
A Simple Trade Model of Discrimination. 9
Employer Model of Racial Discrimination 11
Employee Model of Discrimination. 13

IV. RACIAL DISCRIMINATION AND UNCERTAINTY: THE EMPLOYER SEARCH PROCESS. 15
A Simple Adaptive Model 17
An Adaptive Model of Profit Maximization. 20

V. RACIAL DISCRIMINATION AND UNCERTAINTY: EMPLOYEE SEARCH PROCESS. 22

VI. CONCLUSION. 25

REFERENCES 27

I. INTRODUCTION

Even a cursory study of poverty in the United States reveals the special economic problems confronting non-whites. The proportion of poor who are non-white far exceeds the proportion of non-whites in the total population. Indeed, if attention is restricted to the chronically poor or the "stayers" in poverty (those who remain in poverty year after year regardless of such exogenous factors as economic growth), it has been estimated that non-whites constitute 40 percent of this group.[1] If attention is further restricted to the 1962-1965 time period,[2] approximately one-third of the prime working age (25-54) males who were covered by Social Security and earned less than $3,000 per year for each of these four years were non-white.[3] This study is an attempt to explain this poor performance of non-whites in the job market.

It is clear that ever since Negroes[4] were brought to the United States, they have incurred a variety of injustices ranging from slavery to racial discrimination. The effects of these injustices have been cumulative and difficult to disentangle. However, it does seem that the current economic plight of the Negro is a combination of past injustices and present day discrimination. Discrimination appears in a variety of ways and in several distinct fields. The primary fields in which discrimination occurs are education and training,[5] housing,[6] and occupation. The economic analysis described herein could be applied to any one of these fields. It could also be applied to other groups who are subject to discriminatory practices, such as

---

[1] See Miller (14).

[2] Money GNP grew by approximately 20 percent during this period, with a relatively constant price level. The male unemployment rate dropped from 5.2 percent in 1962 to 4.0 percent in 1965. By 1966 it had decreased to 3.3 percent.

[3] See McCall (12).

[4] Approximately 90 percent of non-whites are Negro.

[5] See Thurow (22).

[6] See Pascal (16).

women and the aged. For specificity, this Memorandum will present an economic analysis of discrimination as it occurs in the job market for non-whites. Most of the economic models of job discrimination and empirical results are not novel.[1] A novel feature of this study is the introduction of a model of racial discrimination that incorporates uncertainty and explicitly considers both the cost of searching for employment by potential employees and the cost of searching for productive employees by employers.[2]

In the literature on job market discrimination a question that frequently arises is the economic value of discrimination accruing to the discriminator (in the case to be discussed here, the employer). Is it positive or negative? If positive would it pay the minority group to engage in retaliatory discrimination? The answers to such questions have usually been obtained by applying a static economic model. Different answers are given depending on which static model is used. The answer to this question is quite important from a policy perspective. If discrimination does not pay economically, then one can estimate the cost of indulging this taste. Employers may then decide that the cost is too high and reduce discrimination without altering their attitudes toward non-whites. If discrimination does pay economically, then different policies may be required to reduce it. It will be argued here that in the presence of uncertainty, discrimination may be economically justified for both the white employer and the non-white employee.

The employer discriminates on the basis of color if when presented with two individuals, one non-white and one white, who are otherwise equally qualified (on the basis of such variables as education, experience, age, sex, and so on) for a single job occupancy, he does not flip a fair coin and choose the non-white if a head appears and the

---

[1] They are contained in the work of Arrow (1), Becker (2), Gilman (4), Hanoch (5), Thurow (23) and others.

[2] The economics of job search has received much attention in the recent literature. See Dufty (3), McCall (10, 13), Alchian, Holt, Mortenson, and Phelps in Phelps (17), Reder (19), and Stigler (21).

white if tails (or vice versa). If the probability of a head is less than one half he discriminates against non-whites; if this probability exceeds one half he discriminates against whites. Employees discriminate if they do not search for employment with the same intensity in firms and industries that are similar with respect to such variables as distance from home, wage rates, and so on and only differ in the proportions of non-whites in their labor forces.

It may pay employers to discriminate because information concerning the productivity of a potential employee is quite costly. He may, therefore, use color as a cheap screening device in the same way that he uses a high school diploma. He does this because he believes that the probability that an employee will be productive given that he's non-white is less than the corresponding conditional probability for whites. In the same way, assuming similar jobs across firms, it may pay non-whites to restrict their job searching activities to firms that have a relatively high proportion of non-white employees, the belief being that this proportion is a good measure of employer discrimination.[1]

Nevertheless, although the value of discrimination tends to be positive, the theory presented here assumes the value is a function of the business cycle. A changing economic environment is assumed to induce employers to engage in experiments, for example, hire non-whites in periods of tight labor markets. The outcomes of these experiments may alter whatever incorrect attitudes they might have toward non-whites, and in this way discrimination could decline in a very natural way. Similarly, with non-white employees, their beliefs regarding the intensity of discrimination in certain industries would never be altered unless they or someone in their information network were employed by these industries.[2] Again in periods of tight labor markets, employees are also assumed to be experimenting with new industries and revising

---

[1]Actually, employer discrimination may be measured by much cruder variables such as the number of friends and relatives that have been hired or are employed by a particular firm.

[2]For a discussion of Negro job searching behavior, see Sheppard and Belitsky (20), Liebow (8), and Lurie and Rayack (9).

their beliefs concerning discrimination intensities. The main point in both of these illustrations is that discrimination by both employers and employees is explicable on purely economic grounds when uncertainty is explicitly considered and, furthermore, changes in the economic environment may cause both employers and employees to alter the beliefs that give rise to discriminatory practices.

Section II summarizes the results of several empirical studies concerning the presence of discrimination in the job market. Section III presents three static models of racial discrimination. The first is a simple trade model, the second is a model developed by Becker (2), and the third is an elementary production function model. The main question addressed by all three is the economic value of discrimination to the discriminator. In Section IV uncertainty is introduced and the employee-seeking behavior of a discriminating employer is modeled. Section V switches emphasis from the employee-seeking employer to the job-searching employee. Uncertainty continues to be present and the searching employee has definite expectations regarding the discriminating behavior of various employers. The concluding section contains some suggestions for future research.

II. SOME EMPIRICAL RESULTS ON RACIAL DISCRIMINATION IN THE JOB MARKET

This section presents a brief summary of the empirical findings of several studies that have addressed the problem of racial discrimination in the job market. None of the measures of racial discrimination is ideal in that each is consistent with hypotheses other than racial discrimination.[1] Nevertheless, the three measures discussed here, unemployment, returns to education, and persistent poverty and non-poverty, all suggest that racial discrimination is present in the job market and that further research is necessary both to assess its actual extent and importance and to devise policies for its elimination.[2]

The first measure of discrimination is the difference in the persistence of poverty and non-poverty among whites and non-whites. In a period of sustained growth (1962-1965) the probabilities of remaining in poverty ($3,000 poverty line) for the entire period were .20 and .05 for non-white and white males, respectively, in the 25-34 age group. Almost identical probabilities were obtained for non-white and white males in the 35-44 and 45-54 age groups. The probabilities of remaining in poverty the entire four year period were remarkably similar for non-white males and white females. (See Table 1). On the other hand, the probabilities of remaining in non-poverty ($3,000 poverty line) for the entire four year period were .60 and .29, for white and non-white males, respectively, in the 25-34 age group. Similar results were obtained for the 35-44 and 45-54 age groups. (See Table 2).[3] Some portion of these differences could probably be explained by job market discrimination. It is very likely, however,

---

[1] Indeed, the inadequacies associated with these measures are so great that any interpretation of them must proceed with extreme caution. They do, however, clearly illustrate the modifications needed to achieve a true measure of racial discrimination, that is, one that adjusts for all differences in qualifications. Unfortunately such an empirical measure is very difficult to obtain.

[2] See Arrow (1) for a more complete discussion.

[3] See McCall (12) for a more complete discussion of these results.

Table 1

PROBABILITY OF REMAINING IN POVERTY FOR THE PERIOD 1962-1965
($3,000 poverty line)

White Females	White Males	Age Group	Non-white Males
.16	.05	25-34	.20
.21	.05	35-44	.19
.25	.06	45-54	.21

Table 2

PROBABILITY OF REMAINING IN NON-POVERTY FOR THE PERIOD 1962-1965
($3,000 poverty line)

White Males	Age Group	Non-white Males
.60	25-34	.29
.65	35-44	.36
.63	45-54	.35

that a large fraction of the differences could be explained by differences in education and training.[1]

Another more refined measure of racial discrimination in the job market is the difference in unemployment rates between whites and non-whites. Gilman (4) was able to adjust for differences in age, education, occupation, industry, and region. After making these adjustments he discovered that non-white unemployment rates were still 50 percent higher than white rates. This suggests that employers have a preference for white employees.

The final indicator of job market discrimination is the difference in annual income as a function of years of education and years of experience. Estimates of these differences were made by Thurow (22) and are presented in Table 3.[2]

---

[1]One could claim that these differences simply indicate the natural inferiority of non-whites in regard to whites. Unfortunately, this hypothesis cannot be refuted by any of the empirical findings reported here.

[2]Also see Arrow (1), Hanoch (5) and Miller (14) for alternative measures.

Table 3

DIFFERENCES IN ANNUAL INCOME (1960)

Education (20 years of experience)		Experience (10.5 years of education)	
Years of Education	White-Non-white Income	Years of Experience	White-Non-white Income
0	$ 624	0	-$ 700
8	1446	5	1351
12	2356	15	1724
16	5477	35	2626

III. STATIC MODELS OF RACIAL DISCRIMINATION

In this section three elementary models of racial discrimination are presented. They are all static and assume perfect information. The first is a simple trade model; the second is a model of a discriminating employer; and the third is a model in which the employer does not discriminate, but instead is confronted by a production function that reflects the discriminating attitudes of white employees against non-white employees.[1]

A SIMPLE TRADE MODEL OF DISCRIMINATION

Assume there are two individuals, W and B, and two goods, X and Y. The utility functions of W and B are, respectively, $U_W(X,Y)$ and $U_B(X,Y)$. The marginal rates of substitution of X for Y by W and B are, respectively, m_1 and m_2.[2] Let m_1 be greater than m_2. (This situation is represented by point A in the Edgeworth box diagram of Fig. 1.) Then under normal conditions trade would take place. Since X is more valuable to W than it is to B, B will give up some X to get more Y and W will give up some Y to get more X. Both will be better off and improvements will persist until the contract curve ($O_W O_B$ in Fig. 1) is reached, that is, until the marginal rates of substitution are equal, say, to m. (Point C in Fig. 1.) Discrimination certainly exists if before trade commences, W is made aware of the color of B and for that reason refuses to trade. A lower bound on the intensity of W's discriminations can be measured by the utility that W would derive in moving from m_1 to m. This is the pecuniary cost of indulging in discrimination.

The question immediately arises as to who benefits from this discrimination. Obviously, in purely pecuniary terms both W and B

---

[1] See Arrow (1) for a delicate analysis of more sophisticated static models.

[2] The marginal rate of substitution, MRS_{xy}, is the amount of Y the individual is willing to give up to get one more unit of X. More precisely, it is the first derivative of the indifference function relating X and Y. (See Fig. 1.)

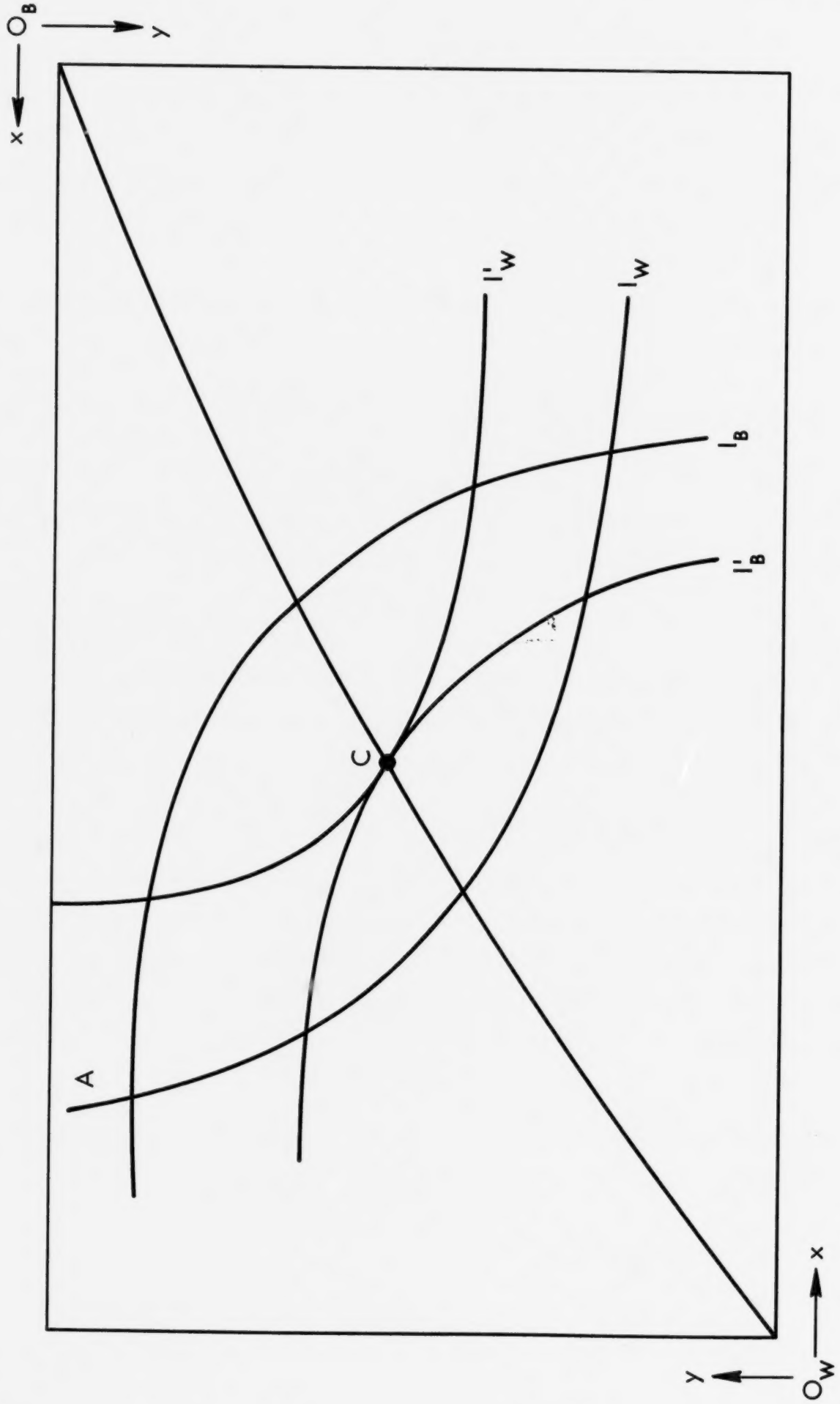

Fig. 1—Edgeworth box diagram

are losers since both remain at m_1 and m_2, respectively.[1] When the taste for discrimination is included in W's utility function, then W gains and B loses.[2]

EMPLOYER MODEL OF RACIAL DISCRIMINATION

Consider now a production function in which there are two inputs, black bricklayers, B, and white carpenters, W, and a single output, houses, q,

$$q = f(B, W)$$

As usual assume that the employer (contractor) wishes to minimize the cost of producing a given number of houses.[3] Let p_B and p_W be the wage rates for blacks and whites, respectively, and mp_B and mp_W their respective marginal products. The marginal rate of technical substitution, MRTS, is the slope of the isoquant, $q_o q_o$, in Fig. 2. Symbolically,

$$MRTS_{BW} = \frac{mp_B}{mp_W}$$

If the contractor initially spends C dollars then his budget line is given by:

$$p_W W + p_B B = C .$$

This is the line in Fig. 2 with end points $(C/p_W, C/p_B)$. In the absence of discrimination the employer will operate at the point A where

$$MRTS = p_B/p_W ,$$

---

[1] Actually, W will look for someone with a utility function like B's, but of the right color. Presumably B will do likewise. The cost of this added search would represent the true pecuniary loss.

[2] Becker (2) presents a more elaborate trade model in which a white country possessing excess capital considers trade with a non-white country possessing excess labor. For a critique of this model see Arrow (1), Krueger (7) and Wohlstetter (24).

[3] The exact number of houses produced is, of course, determined so as to maximize contractor profits. Here it is assumed that the market for houses is perfectly competitive, i.e., the contractor has no control over product prices.

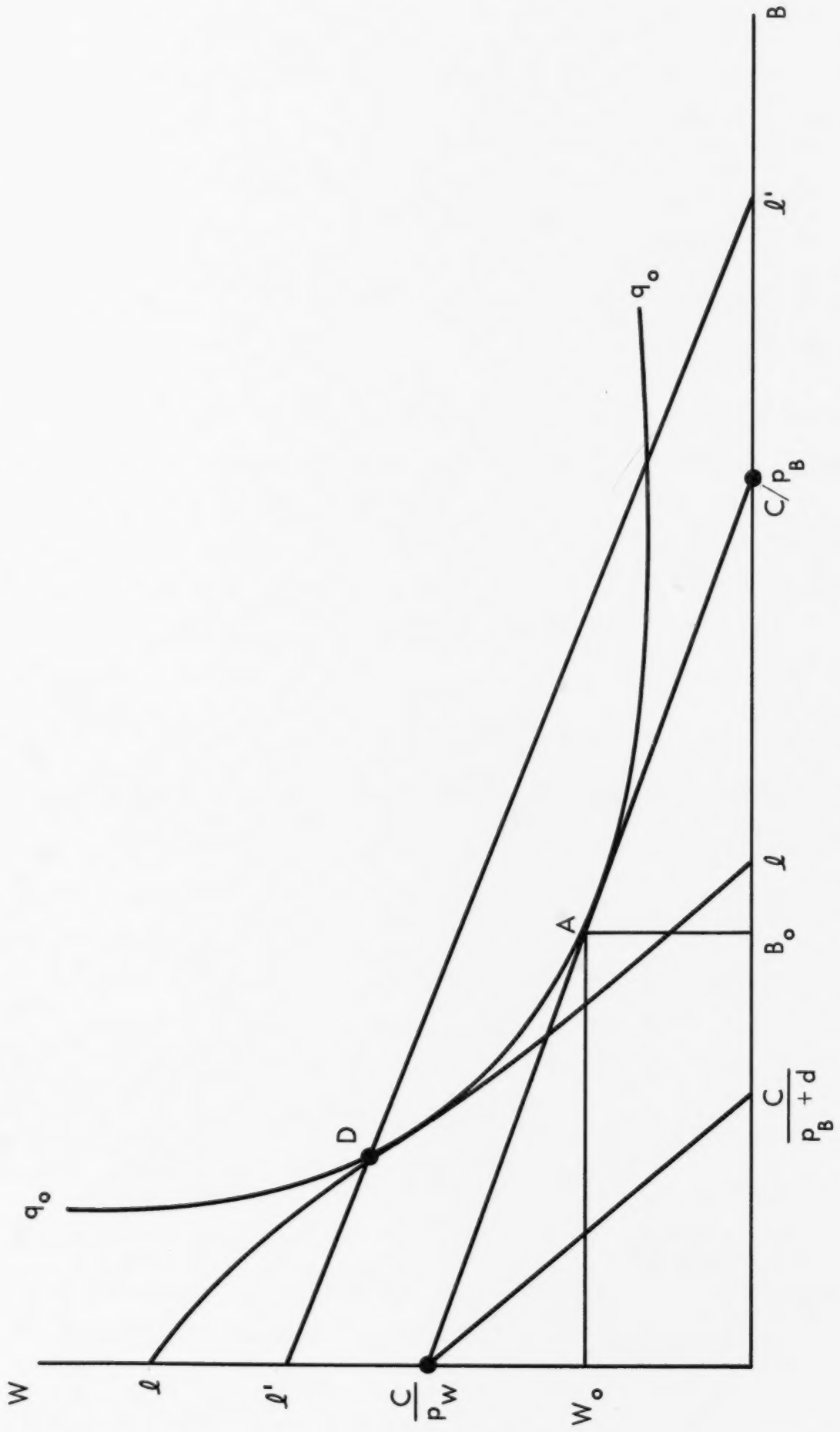

Fig. 2— Isoquant-Isocost diagram

hire B_o black bricklayers and W_o white carpenters and achieve the required output q_o. Now suppose the contractor discriminates against blacks. The discrimination manifests itself in the following way. Instead of observing the true market wage for blacks, p_B, he observes $p_B + d$, $d > 0$, where d is a measure of the intensity of his discrimination. This being the case he now operates at the point where

$$\text{MRTS} = \frac{p_B + d}{p_W} \quad .$$

The slope of his budget line increases. He still desires to produce q_o. Hence, he moves from point A to point D. The actual cost of producing q_o is the cost, C', associated with the line, $\ell'\ell'$, that passes through D and is parallel to the line with slope p_B/p_W. The cost C' exceeds C, so once again discrimination does not pay on purely economic grounds. The difference C'-C is the monetary loss incurred by the contractor when he discriminates with intensity d. This monetary loss is an increasing function of d. If this model were applicable to the real world employers might alter their discriminatory practices when made aware of their real monetary costs.

Jack Hirshleifer has proposed an alternative model in which resources (instead of wages) are held constant. In this circumstance, the labor supply curves are vertical at B_o and W_o for the representative firm of Fig. 2. With the introduction of discrimination, the equilibrium must remain at A. This can occur only if the black wage rate, p_B, declines by exactly the amount of the discrimination coefficient, d. Thus, discrimination affects wages rather than employment. The "correct" model in this context is probably some combination of the Becker and Hirshleifer models.

EMPLOYEE MODEL OF DISCRIMINATION

In this model the employer practices racial discrimination because of the tastes and preferences of his white employees. The presence of

such tastes and preferences results in lower production when white employees work with blacks. Assume that there are three factors of production, capital, K, black labor, B, and white labor, W. For simplicity assume further that capital is fixed and labor is the only variable factor. The production function is given by:

$$q = \alpha_1 KW + \alpha_2 KB - \alpha_3 W^2 - \alpha_4 B^2 - \alpha_5 K^2 - \delta B, \; W > 0,$$

where all the coefficients are positive and δ measures the discrimination intensity of white employees. The marginal products of white and black labor are, respectively,

$$mp_W = \alpha_1 K - 2\alpha_3 W$$

$$mp_B = \alpha_2 K - 2\alpha_4 B - \delta$$

The marginal rate of technical substitution of blacks for whites is therefore

$$MRTS_{BW} = \frac{\alpha_2 K - 2\alpha_4 B - \delta}{\alpha_1 K - 2\alpha_3 W} \quad .$$

The number of whites that can substitute for one black and keep output constant is a decreasing function of δ. The greater the employees' discrimination intensity, the smaller the number of blacks that will be employed (for fixed amounts of capital).

IV. RACIAL DISCRIMINATION AND UNCERTAINTY: THE EMPLOYER SEARCH PROCESS

In the models of the previous section, it was assumed that employers had perfect information about prices, marginal products, and all other relevant economic variables. Such information is, of course, not actually possessed by employers who produce in an environment that is characterized by uncertainty and costly information. For example, the prior assessment of potential employees' marginal products could be very costly. Hence when searching for productive employees, the employer will attempt to utilize relatively costless information devices. Cheap information sources such as age, race, sex, and education will very probably be used as screening devices. This is especially true in surplus labor markets.

Considering only racial discrimination within this context, the employer will hire white employees rather than non-whites with the same apparent abilities. This choice will be based on the prior assessment that the employer has regarding the relative productivities of whites and non-whites, namely that the probability of a success given that the employee is white is greater than the probability of a success given that the employee is non-white.

The employer also has prior evaluations of the discrimination intensities of his white work force and their effect on total production.

Both sets of prior assessments will remain unaltered until the employer begins hiring non-whites. This will increase in tight labor markets when the apparent quality differentials between whites and non-whites outweighs the information provided by the non-white filter. More specifically, the prior assessment of the quality of the white unemployed labor pool will be revised downward as samples from this pool contain more individuals who have failed to make it in other firms. At some point then experiments with non-white employees will commence and employers may revise their prior assessments. If their experience with non-whites is favorable then presumably the use of color as a screening device will diminish when the labor market becomes less tight.

As an illustration, suppose there are two possible states of nature:

S_1: Non-whites inferior (in production) to whites with comparable (easily observed) characteristics.

S_2: Non-whites as productive as their white counterparts.

Suppose also that the employer's prior probability distributions over these two states of nature are

$$P'(S_1) = .9$$

and

$$P'(S_2) = .1$$

The employer hires a non-white and observes one of two outcomes;

Z_1: Non-white is inferior (in production)

or

Z_2: Non-white is productive as white.

Let the probability of observing each of these outcomes given S_1 and S_2 be given by:[1]

$$f(Z_1/S_1) = .8 \qquad f(Z_1/S_2) = .2$$

$$f(Z_2/S_1) = .2 \qquad f(Z_2/S_2) = .8$$

If a Z_2 is observed, the employer's posterior assessments of S_1 and S_2 are by Bayes rule:

$$P''(S_1/Z_2) = .7$$

and

$$P''(S_2/Z_2) = .3$$

If employers' prior distributions are adjusted in this way and non-whites are at least as productive as their white counterparts, then racial discrimination should diminish over time.

To provide a more theoretical framework for analyzing employer searching behavior several alternative models will be discussed. The

[1]This assumes that the experiments do not yield perfect information.

first is a simple adaptive model that assumes that the employer is uncertain about the marginal productivities of both white and non-white potential employees. An employee is successful if his marginal product exceeds some critical value; otherwise he fails and is discharged. The employer is assumed to have prior distributions over the proportion of non-whites who will be successful and the proportion of whites who will be successful. He will hire a white or a non-white depending on the relative expected gain. Each white (non-white) observation provides the employer with an opportunity to revise his white (non-white) prior distribution. Several variations of this model will be presented. The second model is also adaptive with the employer's goal of profit maximization being explicitly assumed. Once again the employer is uncertain about production function parameters, but gains information over time.

A SIMPLE ADAPTIVE MODEL

In this formulation it is assumed that an employee is successful if his marginal product exceeds some critical value, m^*; otherwise he fails and is discharged. The employer has prior probability distributions over the two unknown parameters, p_1 and p_2, where p_1 is the proportion of prospective white employees whose marginal product exceed m^* and p_2 is a similar measure for non-whites. These prior probability distributions are based on both the past experience of the employer and his subjective assessments. Obviously, his subjective assessments will tend to dominate his non-white prior distribution if he has had only limited experience with non-white employees.

The employer is also assumed to have estimates of the costs of determining whether white and non-white marginal products exceed m^*. Let these costs be denoted by c_1 and c_2, respectively. They include the cost of search and the costs incurred while a decision is being made with respect to the employee's productivity. Clearly, c_1 and c_2 are also random variables and presumably the employer will also be revising his estimates of them in the same way as for p_1 and p_2. For simplicity, it will be assumed that these revisions are occurring, but

the adaptive method will not be spelled out. These costs should therefore be interpreted as expected costs given all previously relevant information, and for this reason, will be denoted by $\bar{c}_1$ and $\bar{c}_2$.

The employer is assumed to minimize the cost per success.[1] For example, if he hires n individuals, he wants the ratio of total expected cost to expected number of successes, $\frac{n\bar{c}}{np}$, to be as small as possible.[2] That is, he will hire whites or non-whites so as to

$$\underset{1,2}{\text{MIN}} \left(\frac{\bar{c}_1}{p_1}, \frac{\bar{c}_2}{p_2} \right)$$

For analytical simplicity, it is assumed that the prior distributions over p_1 and p_2 are both beta with parameters (r_1,n_1) and (r_2,n_2) respectively.[3] The density functions for p_1 and p_2 are given by

$$\phi_i(p_i) = k_i p^{r_i-1} (1-p)^{n_i-r_i-1}, \quad i = 1,2,$$

where k_i is a normalizing constant.

The employer's adaptive decision rule is simply:

Sample from labor market 1(2) if

$$\frac{\bar{c}_1}{\int_o^1 p_1\phi_1(p_1)dp_1} \underset{(>)}{<} \frac{\bar{c}_2}{\int_o^1 p_2\phi_2(p_2)dp_2},$$

where ϕ_1 and ϕ_2 are the updated posterior success distributions for whites and non-whites, respectively.

Presumably, in periods of tight labor markets ϕ_1 will shift to the left, that is, the number of qualified whites who are currently

---

[1]The desired number of successes will again be dictated by the profit maximizing criterion.

[2]In terms of the profit maximizing criterion, successes will have some explicit value to the firm, say V(np). Then, the appropriate criterion is to sample from that distribution so as to maximize V(np) - nc.

[3]When this is the case the posterior distribution of p given sample information is also beta.

searching for employment diminishes as the white unemployed labor pool becomes dominated by those who have tried and failed. Under these conditions, it will no longer be economical to use simple screening devices like race and employers will begin sampling from the non-white distribution.[1] A simple model like this is another, possibly partial, explanation of the empirical results presented in Wohlstetter and Coleman (25), Kosters and Welch (6), and McCall (11,12). Wohlstetter and Coleman found that during periods of growth (recession) the gains (losses) in non-white income relative to white have been greatest at the lower end of the income distribution. In their analysis, Kosters and Welch discovered that the non-white employment rate increases (decreases) more rapidly during periods of growth (recession) than the white employment rate. A recent analysis of Social Security data showed that in a period of sustained growth (1962-1965), the non-white group who hovered around a given poverty line made greater progress than the corresponding white group. A full test of the discrimination hypothesis presented here would require an analysis of white and non-white earnings over several business cycles. One could then attempt to measure the changes in employer attitudes caused by cycle induced experimentation. In this way, the discrimination hypothesis could perhaps be distinguished from other equally plausible hypotheses. Clearly, this is an important topic for future research.

Another version of this model assumes that the employer is aware of the non-stationarity of the hiring process over the business cycle and adjusts his prior distributions accordingly. In the previous model, information about employees was the only factor influencing the employer's prior distributions. Adjustments to shifting productivity

---

[1] A model could also be devised in which an employer is considering the possibility of hiring a fixed number of non-whites. This experiment will provide him with sample information about non-white productivities. Such an experiment will be performed when the expected value of sample information exceeds its cost. See Pratt, Raiffa and Schlaifer (18).

parameters would be more rapid if the employer knew the nature of the shifting process.

For simplicity, assume that only the white productivity parameter changes with the business cycle. Furthermore, assume that the employer adjusts to this phenomenon in the following manner. If the economy is growing, his prior distribution on p_1 is ϕ_1' ; if the economy is declining his prior distribution is ϕ_1''. In a growing economy new information is fed into ϕ_1' in order to calculate the posterior distribution; in a declining economy, the posterior distribution is calculated by incorporating new information into ϕ_1''. As before, all of this is done in Bayesian fashion, with prior and posterior distributions members of of the beta family. The same switching rule is used as before except that now the employer's behavior is directly influenced by the business cycle.

This remains a simple model of adaptation, but could be easily generalized to accommodate more complex physical phenomena. For example, both white and non-white productivity parameters could be changing and in a much more complicated manner than the zero-one process discussed here. At this point, however, further generalizations of this model do not seem necessary.

AN ADAPTIVE MODEL OF PROFIT MAXIMIZATION

Let the employer's production function be given by:

$$q = f(X_1, X_2; Y)$$

where X_1 and X_2 are the number of white and non-white workers, respectively, and Y denotes all other factors of production assumed to be fixed. Assuming a normal production function but without specifying its exact form, let $\alpha = (\alpha_1, \alpha_2, \ldots \alpha_n)$ be the random vector of coefficients of the production function.

The employer wishes to maximize profits where profits are given by:

$$\Pi = pq - W_1X_1 - W_2X_2 - b$$

where p is the constant per unit price of q, W_1 and W_2 are the competitive wage rates of X_1 and X_2 and b denotes the fixed costs of the other factors. Differentiating Π with respect to X_1 and X_2 and solving for the optimal values of X_1 and X_2, say X_1^* and X_2^*, gives the optimal profit, Π^*,

$$\Pi^* = pf(X_1^*, X_2^*, y) - W_1X_1^* - W_2X_2^* - b$$

where

$$X_1^* = g_1(p,W_1,W_2,\alpha) \text{ and}$$

$$X_2^* = g_2(p,W_1,W_2,\alpha)$$

Finally, assume that p, W_1, and W_2 are known constants, but that α is a random variable with a joint normal prior distribution, F. Each period provides information on α and these are assumed to be generated by a normal process. The prior normal distribution is updated as these new observations occur and a posterior normal distribution is calculated. For example, suppose $\alpha = (\alpha_1,\alpha_2)$ and that α_1 and α_2 are independent and normally distributed with means $\bar{\alpha}_1$ and $\bar{\alpha}_2$ and known variances. Then the employer chooses X_1^* and X_2^* to maximize

$$E\Pi = \iint \Pi^* f(\alpha_1,\alpha_2)d\alpha_1 d\alpha_2 \ .$$

As $F(\alpha_1,\alpha_2)$ changes over time, the relative employment of whites and non-whites also changes.[1]

---

[1]As before if the employer knows more about the relationship between α_1, α_2 and the business cycle, this information can also be incorporated into his decision process.

V. RACIAL DISCRIMINATION AND UNCERTAINTY: EMPLOYEE SEARCH PROCESS

The searching activities of individuals for job vacancies is very similar to the employer's search process. One of the costs of search incurred by non-whites is the probability that they will be rejected because of their color. These probabilities vary from industry to industry and among firms. If this probability is above a critical level for a particular firm or industry, then not applying for a job is the best policy for non-whites.

More specifically let

c = cost per period of search

x = a random variable denoting the job offer, $x \geq 0$

$\phi(x)$ = the probability density function of x

$f(x)$ = maximum return obtainable when a job offer x has just been observed.

The cost, c, is incurred simultaneously with the offer, x. Costs of search include purely economic components such as transportation costs and the value of forgone alternatives as well as psychic components such as the frustration accompanying rejection and the discrimination (by race, age, and sex) present in many employment markets. Here the focus will be on the racial discrimination component of this cost. When the random variable, x, takes on a value of zero, this means that the firm did not make a job offer. The cost of search is an increasing function of the probability that $x = 0$, that is, the higher this probability the greater the chance of rejection.

If search terminates, that is, employment commences after N job offers, then the return, f, is simply the value of the Nth offer, x_N, less the cost of search, c, times the number of job offers:

$$f = x_N - c\,N\ .$$

If an x is observed at the first period and the process continues in optimal fashion thereafter, the return is given by

$$f(x) = -c + \max\,[x,\ E(f(x))]\ .$$

Letting $\varepsilon = E(f(x))$, it is clear from this equation that the optimal policy has the following form:

continue searching if $x < \varepsilon$

accept employment if $x \geq \varepsilon$,

where ε satisfies the following equation

$$c = \int_{\varepsilon}^{\infty} (x-\varepsilon)\ \phi(x)\ d\,x = H(\varepsilon)\ .^{1}$$

Let ε_o denote the expected return from remaining unemployed. Note first that since $H(\varepsilon)$ is a decreasing function of ε,[2] large values of c are associated with small values of ε. This in turn implies that, if other things are equal, as c increases, the length of search decreases. Similarly, small values of c are associated with larger values of ε and longer periods of search. Consider an individual whose expected returns from remaining unemployed are ε_o. If this individual is confronted with search costs in excess of c_o, not searching at all is his best strategy. The value of ε associated with any value of c greater than c_o is less than ε_o, the expected return from remaining unemployed. This is another way of saying that the optimal policy for such an individual is to drop out or join the ranks of the discouraged workers. Alternatively, if the costs of search are less than c_o, the individual will continue to seek employment until he receives an offer exceeding the corresponding value of ε. The time until such an offer is forthcoming is a period of frictional unemployment. A description of the structure of the optimal policy is a convenient device for summarizing the preceding discussion. The optimal policy for choosing between dropping out and frictional unemployment has the following form:

if $c \geq c_o$, do not search (drop out)
if $c < c_o$, search (choose frictional unemployment).

The cost of search tends to be larger for non-whites because of racial discrimination. In addition, the wage distribution, $\phi(x)$, for

---

[1] For a derivation of this result and a more general description of this model, see McCall (13).

[2] The derivative of $H(\varepsilon)$ is equal to minus the probability that the wage offer, x, will exceed ε.

non-whites tends to be inferior to that of whites because of discrimination. Such factors could account for the disproportionate number of non-white dropouts.

In the tight labor markets that accompany sustained economic growth employers should discriminate less.[1] The cost of search should decline and $\phi(x)$, the wage distribution, should shift to the right with less mass being concentrated at zero.[2] Consequently, more non-whites will be employed. More precisely, the number of non-white dropouts will decline, that is, it will now pay them to search for employment. One would also expect that non-whites would enter new industries and occupations. This, however, is an empirical question in that non-discriminating industries may benefit more from economic growth. However, non-whites would probably begin to search in industries where search was previously uneconomical.[3]

---

[1] See preceding section.

[2] For an analysis of search behavior when the searcher is uncertain about $\phi(x)$, see McCall (13).

[3] The effect of a minimum wage can also be interpreted within this model. In many ways it has the same implications as racial discrimination. For example, with respect to $\phi(x)$, higher minimum wages will cause more mass to be concentrated at zero. See McCall (13).

VI. CONCLUSION

The primary purpose of this study was to present elementary models of racial discrimination in job markets where the presence of uncertainty was explicitly considered. Models of both employer and employee behavior were developed.

These models are preliminary and have not been empirically tested. Nevertheless, they do provide new insights into the discrimination phenomenon and suggest the kind of empirical research that should be undertaken. Three types of empirical data were discussed. The first were used to construct crude measures of racial discrimination. Although these measures were suggestive, none was adequate. Indeed, their most important function was to demonstrate the difficulty of measuring racial discrimination. Development of adequate measures is an important task for future research in racial discrimination. The second set of data were used to construct three different measures of the influence of economic growth on the economic welfare of non-whites. The measures were considerably different, but all implied that the effects of economic growth and the attendant tight labor markets were strong and positive. This has definite implications for monetary and fiscal policy. Additional research on this important topic is clearly necessary. The final set of data concerned the behavior of the economic welfare of non-whites over a series of business cycles. Such data could be used to test the discrimination models presented here. Empirical analysis of such data should be a significant component of any future research on racial discrimination.

The interaction between the employer and employee searching activities was not investigated. Similarly, the process by which information is transmitted and disseminated was not studied. These are important topics for future theoretical research.

REFERENCES

1. Arrow, Kenneth J., Measurement of Racial Discrimination in the Labor Market, unpublished Rand paper.
2. Becker, Gary S., The Economics of Discrimination, University of Chicago Press, Chicago, 1957.
3. Dufty, Norman F., "A Model of Choice in an Australian Labor Market," Journal of Human Resources, Vol. 4, Summer 1969, pp. 328-342.
4. Gilman, H. J., "Economic Discrimination and Unemployment," American Economic Review, Vol. 55, December 1965, pp. 1077-1095.
5. Hanoch, G., "An Economic Analysis of Earnings and Schooling," Journal of Human Resources, Vol. 2, Winter 1967, pp. 130-329.
6. Kosters, M. and F. Welch, unpublished Rand paper.
7. Krueger, Anne O., "The Economics of Discrimination," Journal of Political Economy, Vol. 71, October 1963, pp. 481-486.
8. Liebow, Eliot, Tally's Corner, Little Brown and Company, Boston, 1967.
9. Lurie, Melvin and Elton Rayack, "Racial Differences in Migration and Job Search: A Case Study," Southern Economic Journal, July 1966; reprinted in Negroes and Jobs, edited by Ferman, Kornbluh and Miller, The University of Michigan Press, Ann Arbor, 1968.
10. McCall, J. J., "The Economics of Information and Optimal Stopping Rules," Journal of Business, Vol. 38, July 1965, pp. 300-317.
11. -----, "An Analysis of Poverty: A Suggested Methodology," Journal of Business, Vol. 43, January 1970.
12. -----, An Analysis of Poverty: Some Preliminary Empirical Findings, The Rand Corporation, RM-6133-OEO, December 1969.
13. -----, "Economics of Information and Job Search," Quarterly Journal of Economics, Vol. 84, February 1970.
14. Miller, Herman P., "Poverty and the Negro," in Leo Fishman (ed.), Poverty Amid Affluence, Yale University Press, New Haven, 1966.
15. -----, Rich Man, Poor Man, Crowell, New York, 1964.
16. Pascal, A. H., The Economics of Housing Segregation, RM-5510-RC, The Rand Corporation, November 1967.
17. Phelps, E. S. (ed.), Microeconomic Foundations of Employment and Inflation Theory, W. W. Norton, New York, 1969.
18. Pratt, John W., Howard Raiffa, and Robert Schlaifer, Introduction to Statistical Decision Theory, McGraw-Hill, New York, 1965.
19. Reder, M. W., "The Theory of Frictional Unemployment," Economica, February 1969, pp. 1-28.

20. Sheppard, Harold L. and A. Harvey Belitsky, The Job Hunt, Johns Hopkins Press, Baltimore, 1966.

21. Stigler, G. J., "Information in the Labor Market," Journal of Political Economy, Supplement, Vol. 70, October 1962, pp. 94-105.

22. Thurow, Lester, "Occupational Distribution of Returns to Education and Experience for Whites and Negroes," Proceedings, American Statistical Association, Vol. 62, 1967, pp. 233-243.

23. -----, The Economics of Poverty and Discrimination, Brookings Institution, Washington, D.C., 1968.

24. Wohlstetter, Albert and S. Coleman, unpublished Rand paper.

25. Wohlstetter, Albert and Roberta Wohlstetter, "Third Worlds Abroad and at Home," The Public Interest, No. 14, Winter, 1969, pp. 88-107.